

NAVSTAR

Global Positioning System

GPS Modernization
CGSIC



Sep 04
Colonel(s) Mark Crews
Chief Engineer
SMC/GPE



Navstar GPS

Overview



- Mission
- Modernization program
- New civil signals
- Accuracy improvement
- US-EC GPS-Galileo agreement
- Summary



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GPS Joint Program Office (JPO) Mission

- Mission: *“Acquire and sustain survivable, effective, and affordable global positioning services for our customers.”*
- “Civil community objectives will enhance the economic benefit of the GPS by providing more cost-effective operations through a widely available PVT system that will ensure the success of a multitude of applications and safety-of-life missions in an increasingly complex and crowded navigation environment.”
 - *GPS III DRAFT Capabilities Development Document (CDD)*
 - *22 April 2004*

*Strong commitment to deliver robust, modernized
GPS capabilities to civil community*

Civil Use

"The nation's reliance on GPS has become an issue of national security -- national security in its broadest sense, that goes beyond merely national defense." -- Dr. James Schlesinger, March 1997

Power Grid
Interfaces



Personal Navigation



Trucking &
Shipping



Surveying &
Mapping



Aviation



Railroads



Recreation



Communications



Fishing &
Boating



Off shore
Drilling





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Overview



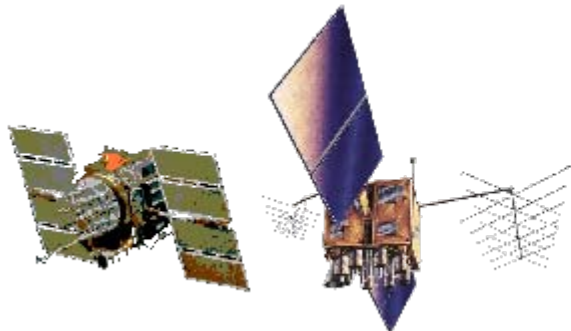
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Navstar GPS Modernization



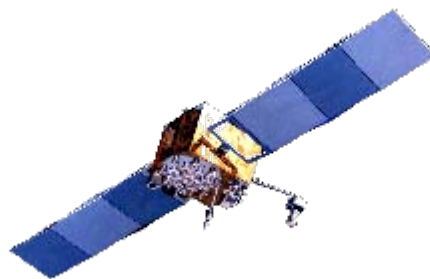
Block IIA/IIR



IIA / IIR: Basic GPS

- C/A civil signal (L1C/A)
- Std Service, 16-24m SEP
- Precise Service, 16m SEP
 - L1 & L2 P(Y) nav

Block IIR-M, IIF



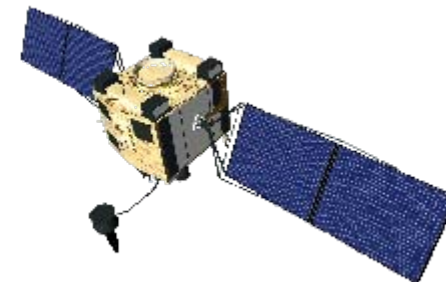
IIR-M: IIA/IIR capabilities &

- 2nd civil signal (L2C)
- **New military code**
- **Flex A/J power (+7dB)**

IIF: IIR-M capability plus

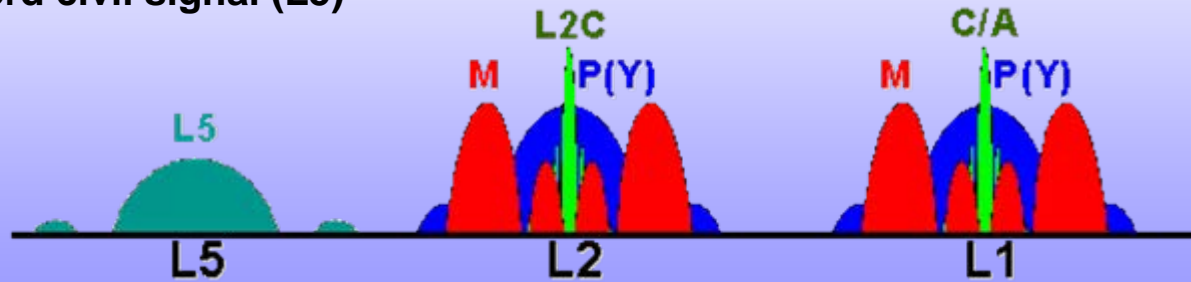
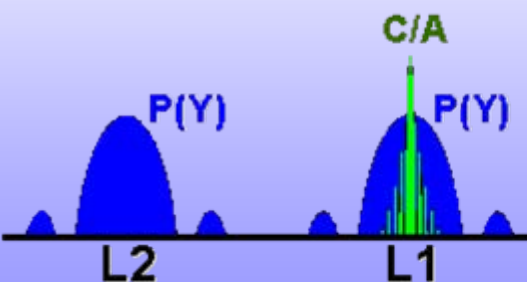
- 3rd civil signal (L5)

Block III



III: IIF capabilities &

- Improved civil signal (L1C)
- Increased accuracy (4.8-1.2m)
- Navigation surety
 - Increased A/J power (+20 dB)



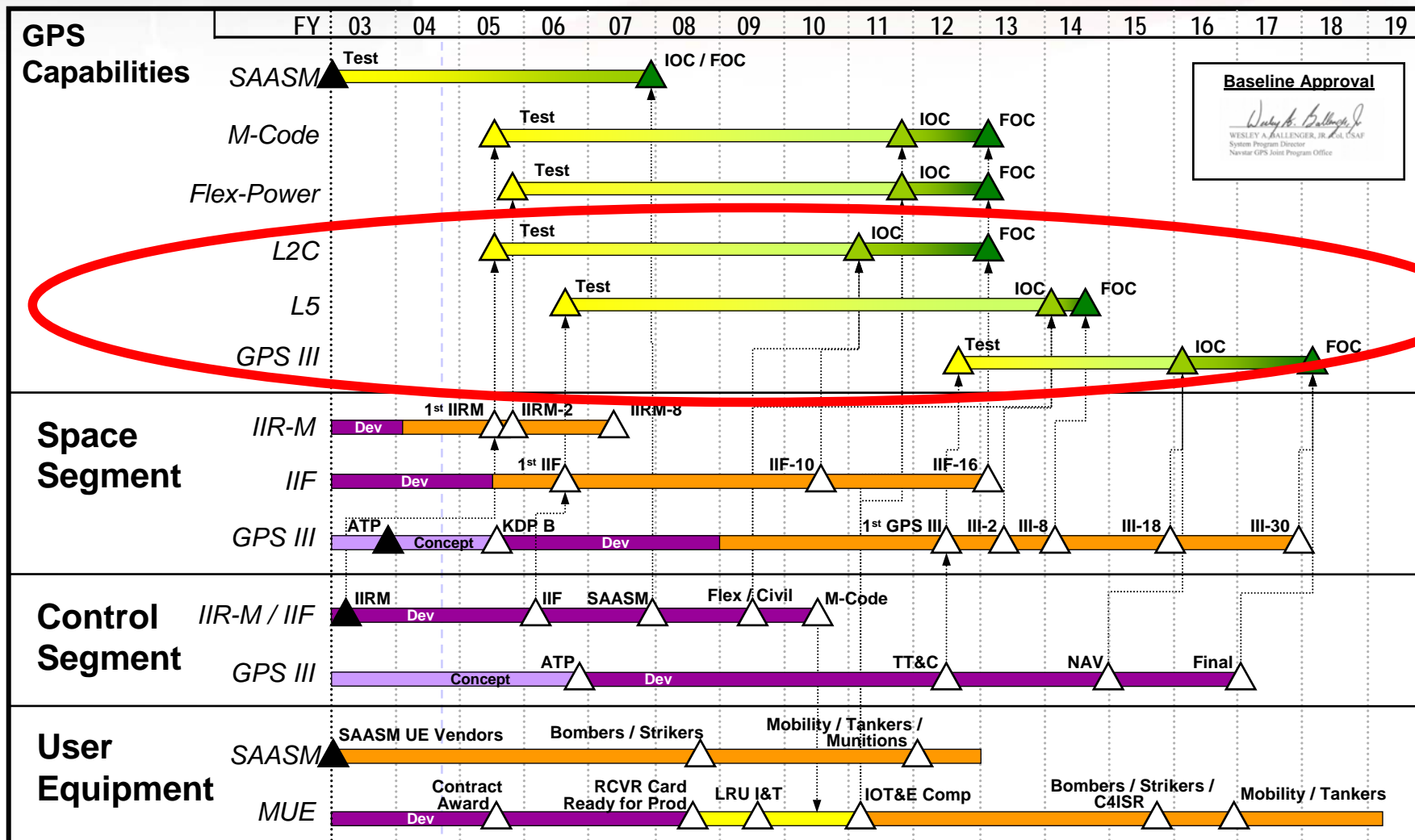
GPS modernization balances military and civil needs



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GPS Enterprise Perspective Schedule

FY05 PB Baseline



Baseline Approval
Wesley A. Ballenger, Jr.
System Program Director
Navstar GPS Joint Program Office

Concept Development Production Test IOC FOC



JPO Approved Baseline Based on FY05 PB
Updated as of: 23 Aug 04 SMR



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L2C Second Civil Signal

L2C



1227.6 MHz

■ Benefits of L2C

- Improves PNT for ~ 50,000 current scientific/commercial dual frequency users
- Extends safety-of-life, single-frequency E-911 applications
- Provides better protection (24 dB) than C/A against code cross correlation and continuous wave (CW) interference
- Improved data structure for enhanced data demodulation (5 dB better than C/A)



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L5 Third Civil Signal

L5



1176.45 MHz

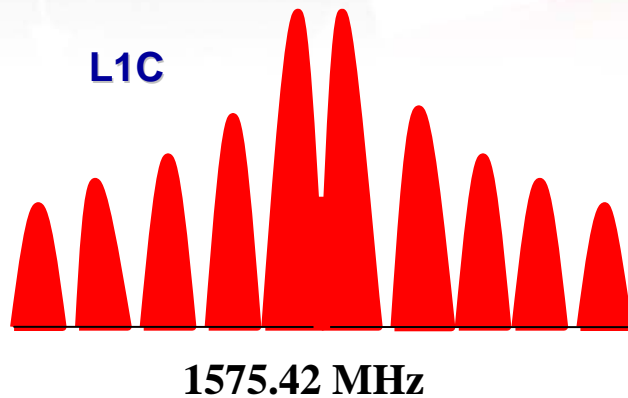
- Improves signal structure for enhanced performance
 - Higher power (-154.9 dBW)
 - Wider bandwidth (24 MHz)
 - Longer spreading codes in the navigation message
- Aeronautical Radionavigation Services band
 - Co-primary allocation at WRC-2000 (1164-1215MHz)
- L5 signal definition in IS-GPS-705



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New L1C Signal Improvements



- Tech solutions exist to add a modernized L1 civil signal
- Implementation will provide C/A code to ensure backward compatibility
- Assured of 1.5 dB increase in minimum C/A code power to mitigate any noise floor increase
- Enables greater civil interoperability with Galileo



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UNCLASSIFIED

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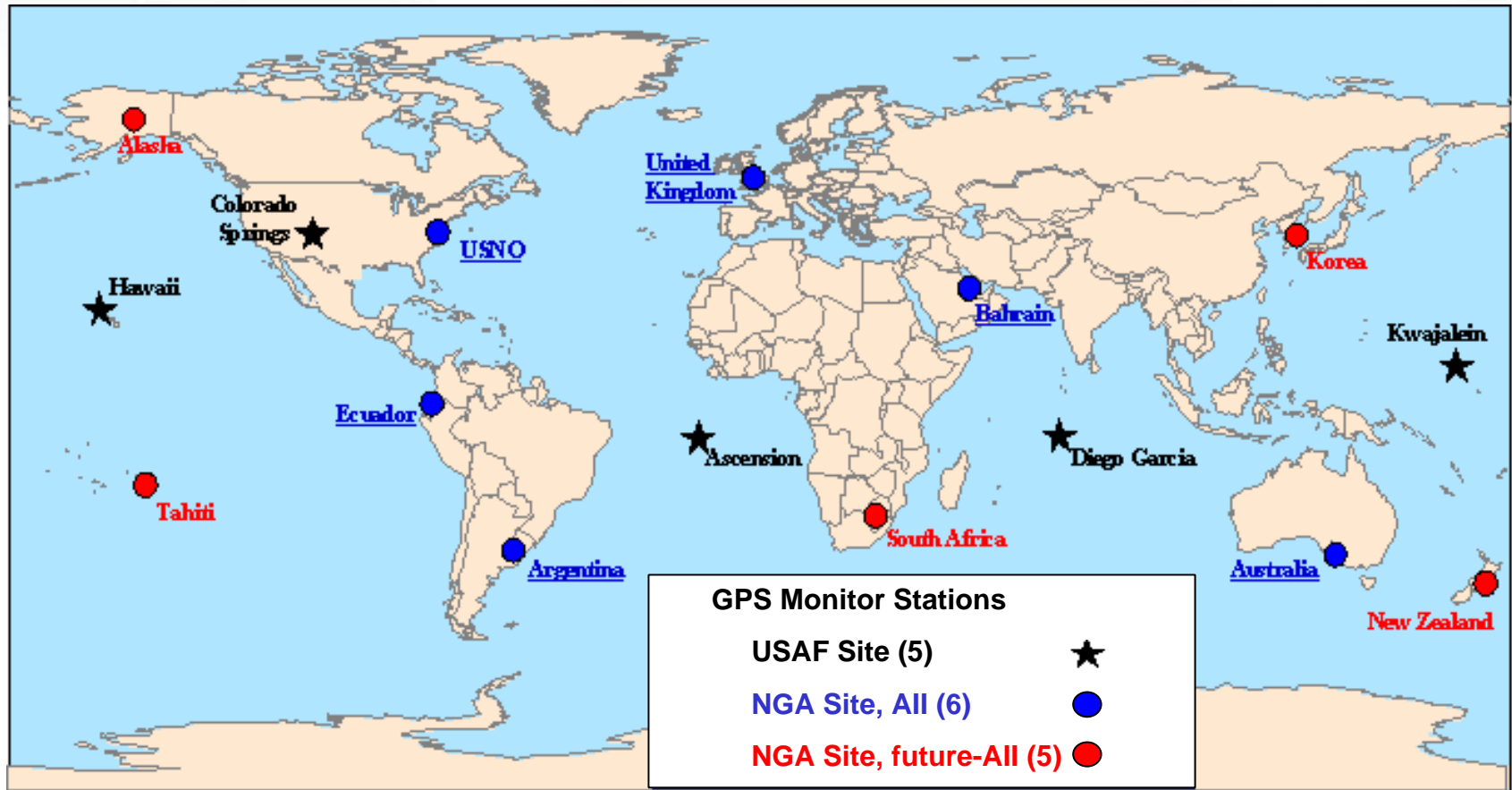


Legacy – Accuracy Improvement Initiative (L-AII)

- Joint effort by USAF & National Geospatial-Intelligence Agency (NGA)
- Objective is to reduce “User Range Error” (URE):
 - URE is produced by errors in GPS satellite orbital position and clock data transmitted to users in the GPS nav data message
- Orbital position & clock data is most accurate immediately after uplink to satellite, but becomes less accurate as its “Age of Data” increases
- By combining USAF & NGA GPS satellite tracking data there is better knowledge of GPS satellite orbits & clocks
 - Result: reduced URE & better navigation accuracy



USAF & NGA Monitor Stations Legacy - Accuracy Improvement Initiative



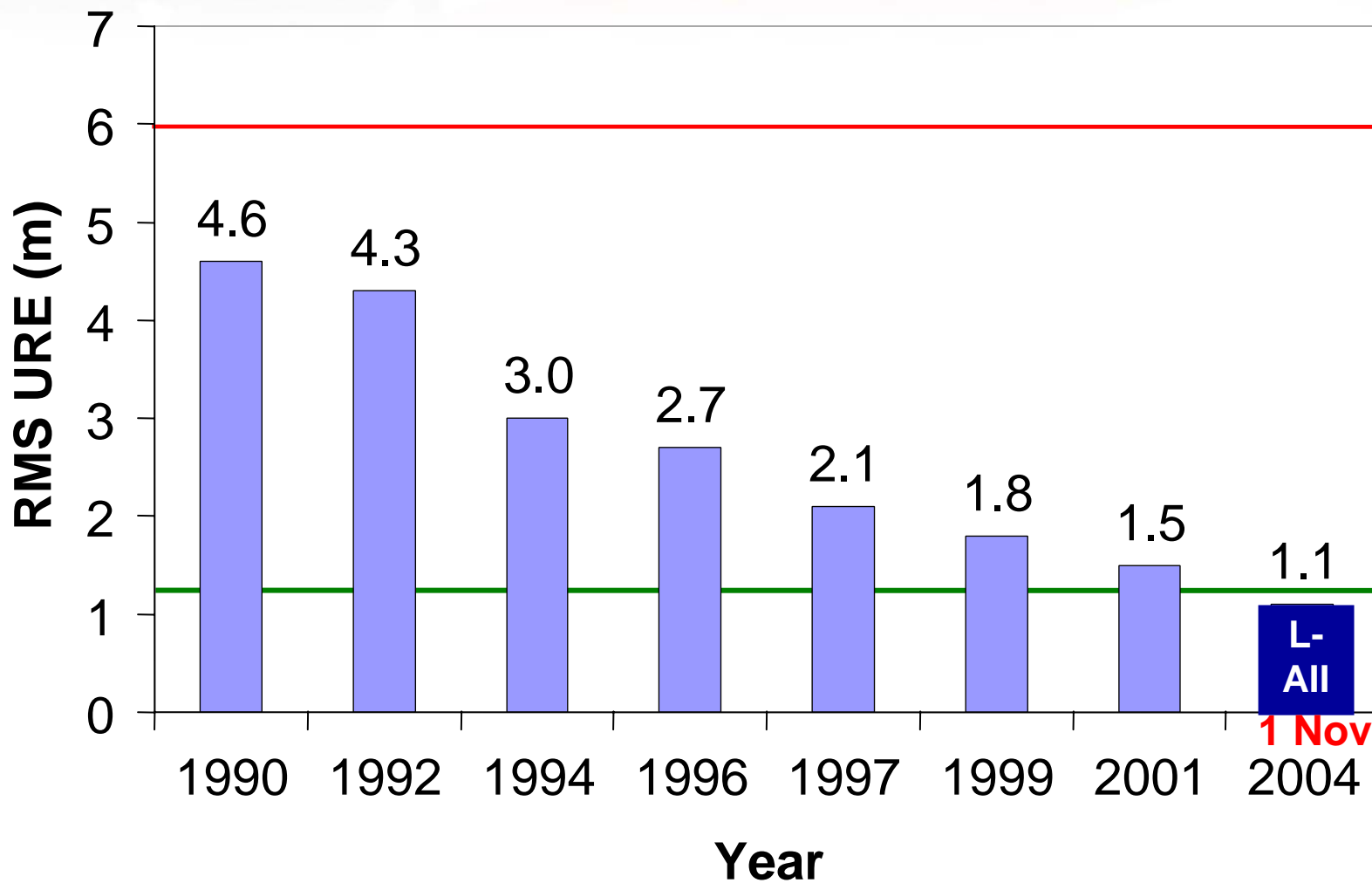
- In Nov 04, NGA sites (Core 6) will be added to AF MS sites
- By CY06, 5 more NGA sites will be added to L-All



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URE Performance History



**1990
SORD**

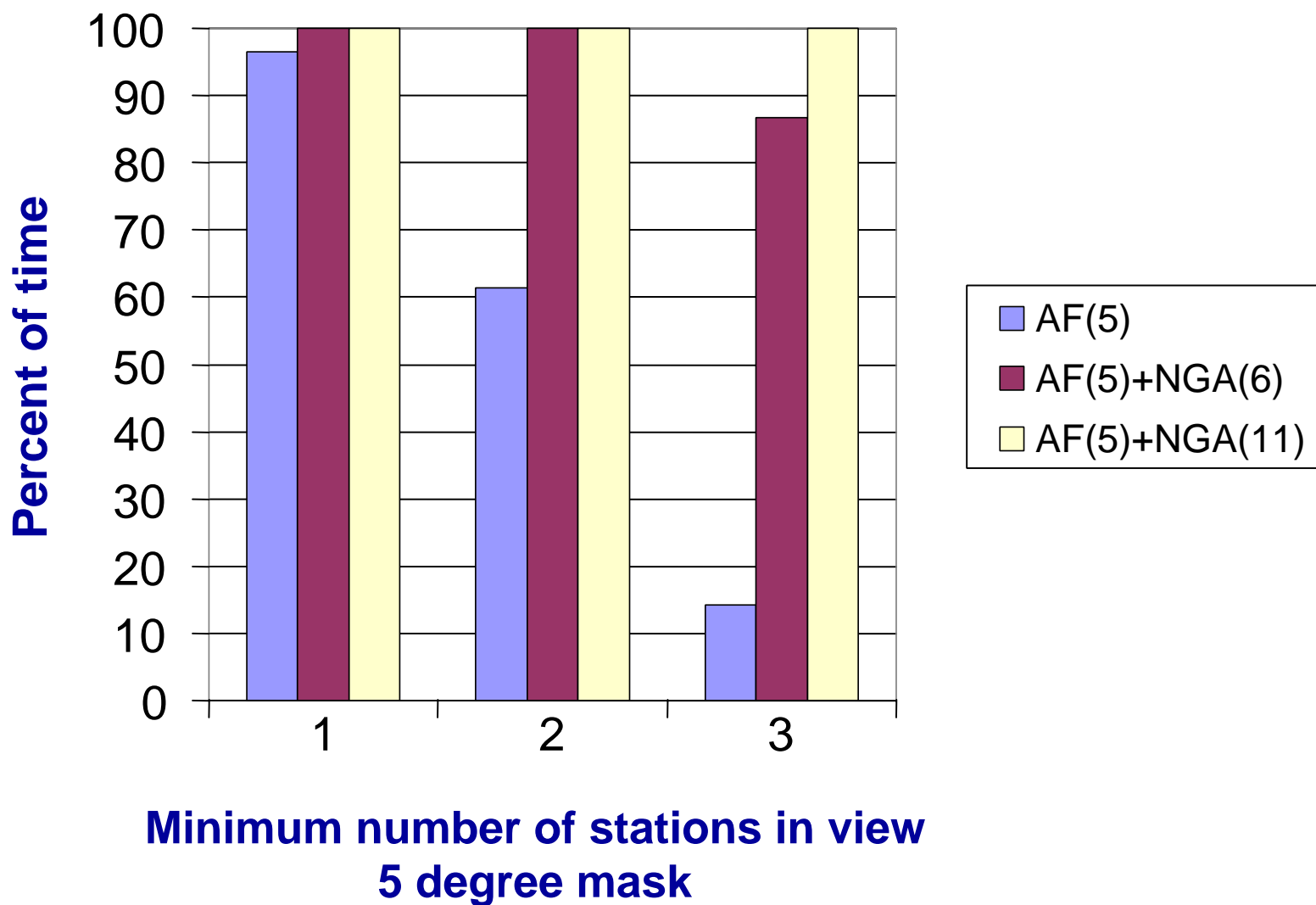
**2000
ORD**

Modernization
Operational
Requirements
Document

No user changes required to accomplish this!



Ground Network Visibility

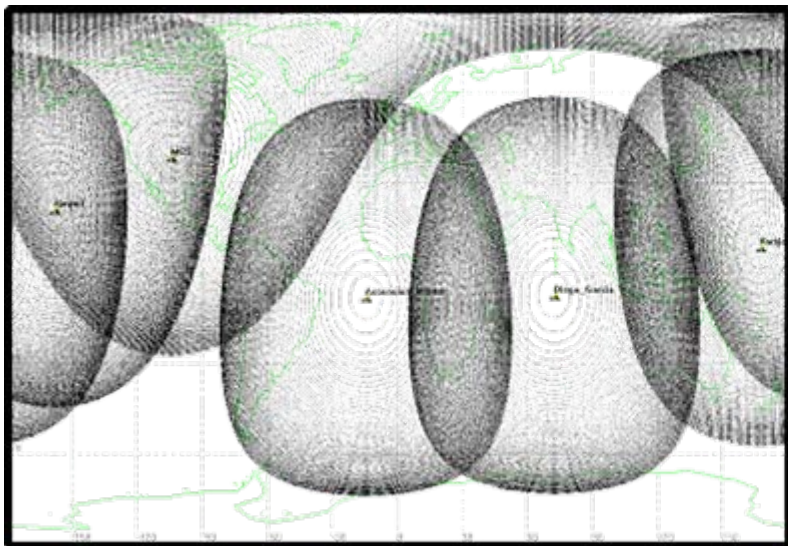




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GPS Satellite Visibility

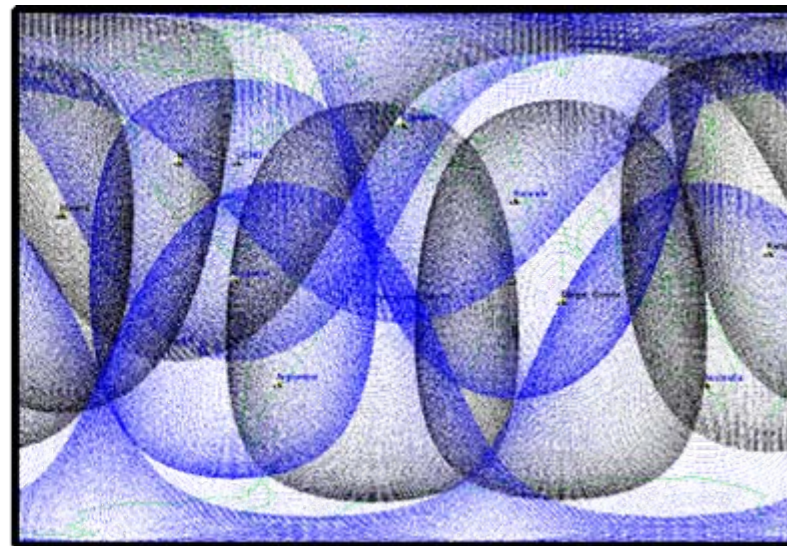


USAF



+

NGA



5 USAF stations

**5 USAF + 6 NGA
stations**

*Increased accuracy with double visibility
for safety of navigation – Mission Success!*



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Navstar GPS *Galileo and GPS: Interoperability and Compatibility*



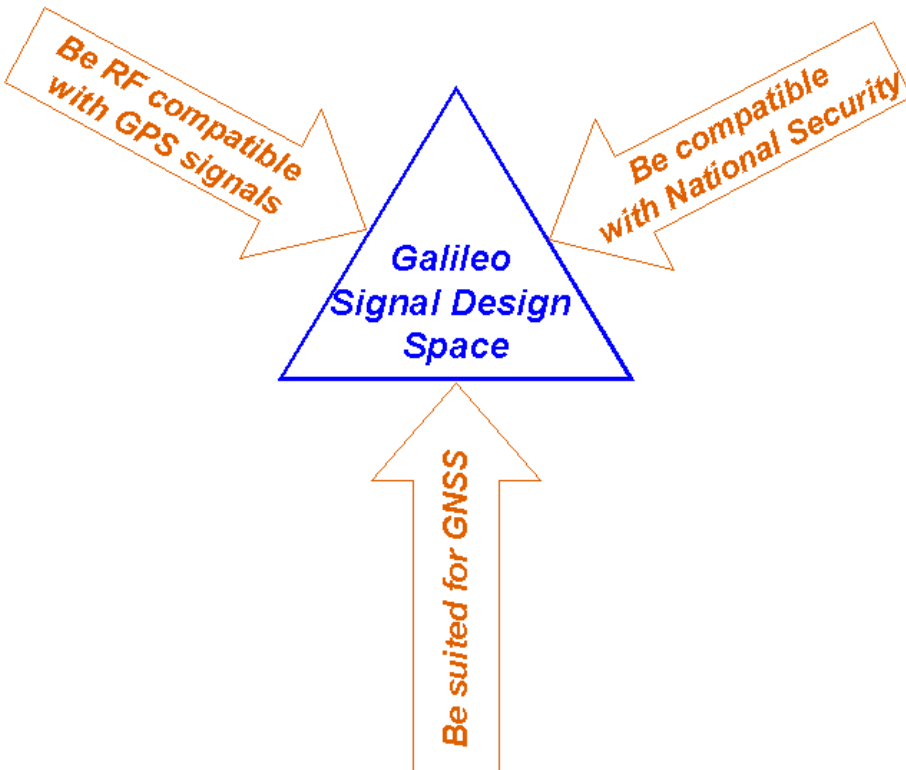
- GPS and Galileo civil signals should be very similar
- Opportunity for U.S. and Europe to agree on a common signal structure at L1 with optimum interoperability
 - Same center frequency, same spectral characteristics
 - Enable common civil receiver designs
 - Obtain even better user navigation performance



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Key issues



- Future civil signals must be RF compatible with current GPS signals
- Future signals should enhance civil GNSS performance
- And be compatible with US National Security

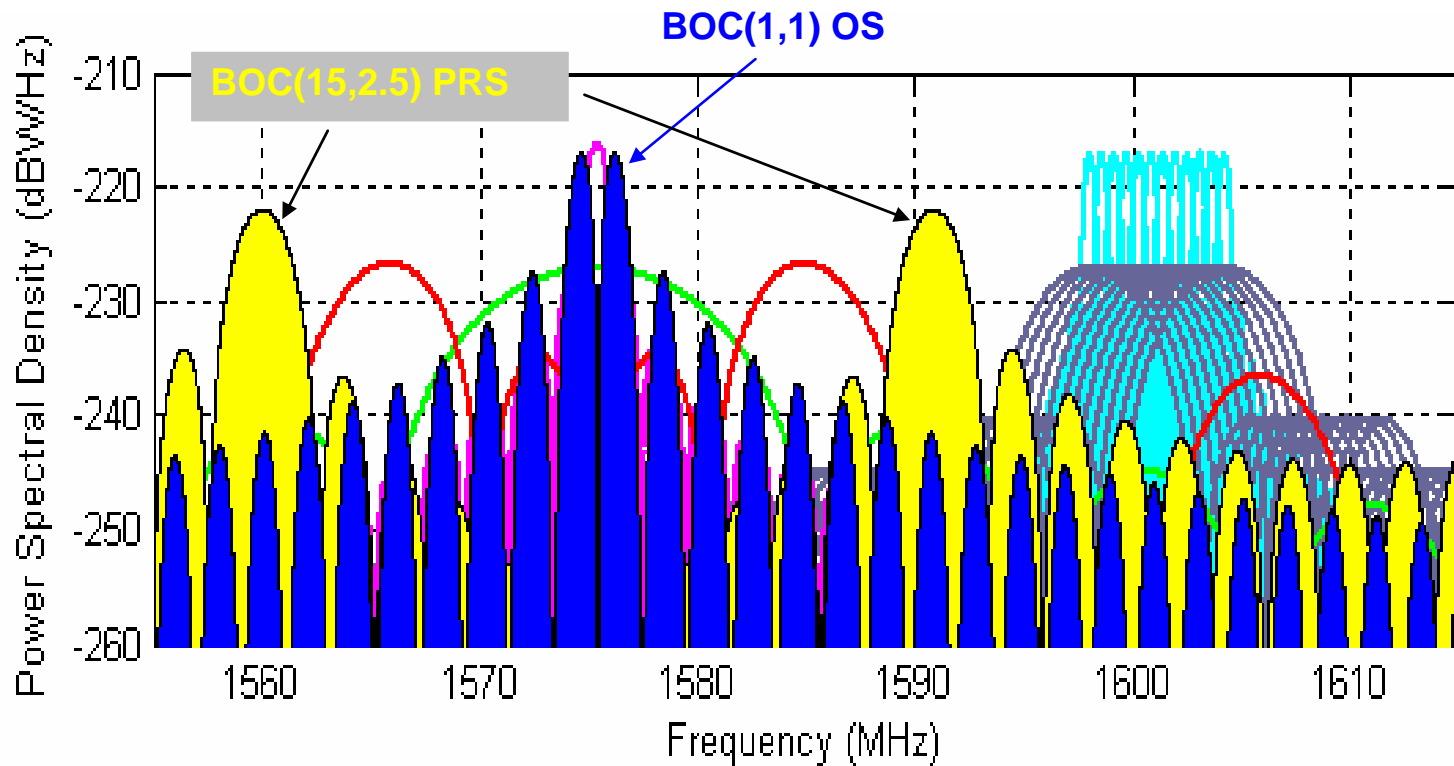
Goal is to find reasonable compromise between civil interests and military objectives



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Baseline Galileo Signals in Agreement Signed June 2004



***Galileo signals spectrally separated from M-code signal
-- US and Europe achieve compromise***



- *Sustaining* constellation performance
 - Launching ~3 per year
 - Fielding GPS enhancements such as L-All
- *Modernizing* by adding new signals and capabilities beginning with first IIR-M1 launch in 2005 and first IIF launch in 2006 (L2C FOC 2013, L5 FOC 2014)
 - New civil and military GPS signals
 - Continuing work with Galileo community
- *Planning* to execute for the next generation
 - Further enhancements continuing through GPS III
 - GPS III – study contracts awarded in January 04

Department of Defense is committed to responsible stewardship of GPS as a global utility